

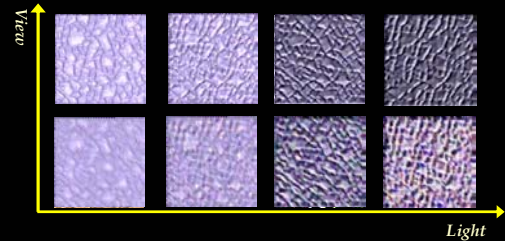
## Synthesis of Bidirectional Texture Functions on Arbitrary Surfaces

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## Real World Texture from CuRet



- Geometry Details (Mesostructure) on Surface
- Self-Occlusion, Self-Shadow, and Specularity



## Bidirectional Texture Functions (BTF)

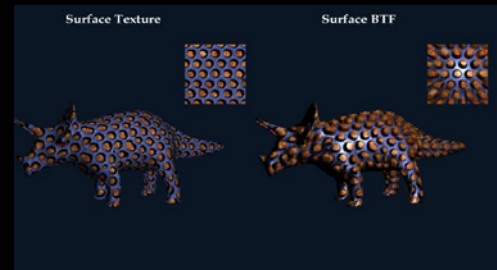
A collection of images of the same surface under different lighting and viewing directions.

— [Dana et. al. 97]

- 6D Function  $(x, y, l_\theta, l_\phi, v_\theta, v_\phi)$
- Dense Sampling in Viewing/Lighting Directions
- Capturing Appearance of Real World Surface

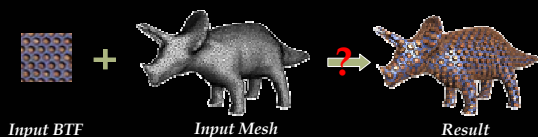


## 2D Texture Map vs. BTF



## BTF Synthesis on Surface

Given a BTF sample ( a dense set of images ) and a triangle mesh, how can we synthesize the BTF over the mesh surface?

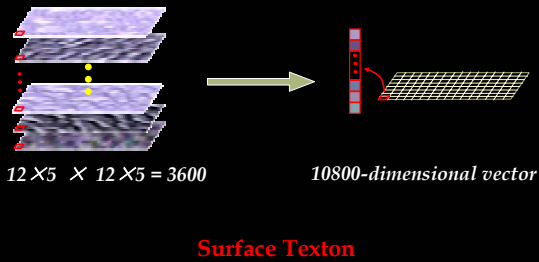


## Desirable Properties

- Good Quality
  - Similar to BTF samples for all lighting/viewing
- Preserve Consistent Underlying Geometry
  - Consistent appearance variation
- Minimal Distortion and High Efficiency
  - Take advantage of algorithms for 2D texture
  - [Wei & Levoy 01], [Turk 01], [Ying et. al. 01]

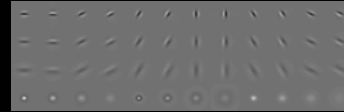


## Treating BTF as a 2D Texture Map



## 3D Texton [Leung & Malik 1999]

- Capturing Microstructures and Reflectance Variations in BTF
  - Keeping consistent geometry
- Represented by Filter Bank Responses Vector (Appearance Vector)
  - Using 48 Gaussian derivative filters for each sample



## Why Not 3D Texton for Synthesis?

- **Problem**
  - Appearance vector is high dimensional
- **Key Observation**
  - Basic computation in synthesis is **dot-product** of 3D textons' appearance vectors
- **Solution**
  - Pre-compute the dot-products and then discard all appearance vectors!

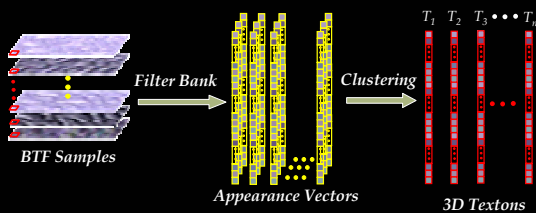


## Surface Texton

- Surface Texton Space
  - Vector space spanned by 3D textons
- Surface Texton
  - Vector in surface texton space
  - Linear combination of 3D textons
- Dot-product Matrix
  - A look up table stores all dot products



## Texton Analysis



## Sample Texton Map

Sample Texton Map

$$\begin{bmatrix} T_1^r & T_2^r & \dots & T_n^r \\ T_1^g & T_2^g & \dots & T_n^g \\ T_1^b & T_2^b & \dots & T_n^b \end{bmatrix}$$

Dot-product Matrix



## Texton Analysis

